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Lesson Plan for STEM Approach at a Junior High School in Yogyakarta

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Abstract. STEM approach has been implemented in several develop countries. The approach has successfully improved students' learning achievement and their ability to solve problems. Several countries have adopted the approach and encourage teachers to implement it. Despite the benefits of STEM approach, the approach is relatively new in Indonesia. There is little research has been carried out and reported. This research was aiming at identifying the potentials and problems of the implementation of STEM approach at Junior High Schools in Indonesia. The research was a pilot project carried out at one Junior High School in Yogyakarta involving Mathematics and Science teachers. The research activities including identification of topics to be taught using STEM approach, developing lesson plan, teaching materials, and reflection. The data collected from the research consisted of list of teaching topics, lesson preparation, teaching video, and students' works. This paper focuses on the result of data analysis regarding lesson preparation process, and the challenge during the preparation of the implementation of STEM Approach in Indonesian schooling system. The lesson plans developed during the research was an integration of statistics and electricity topics.

INTRODUCTION

STEM approach is a term used to refer collectively to the teaching of the disciplines within its umbrella – science, technology, engineering, and mathematics – and also to a cross –disciplinary approach to teaching that increases student interest in STEM relative fields and improves students' problem solving and critical analysis skills. STEM as an entity itself. Integrated STEM education is not just putting technology and engineering layers onto standard science and mathematics curricula. Instead, integrated SEM education is an approach to teaching that is larger than its academic parts [1].

The approach has been adopted and recommended to be implemented in schools in several countries such as US, Australia and UK. In some other countries the research regarding implementation of the STEM approach is developing. The research while demonstrated several potential for STEM as a means to enhance teaching quality and students learning, it also shows some challenges [2], [3].

In Indonesia context, teaching and learning of science and mathematics is separated in junior high school. Moreover, in senior high school teaching and learning of mathematics, physics, biology and chemistry is separated. STEM approach has not been used to teach science and mathematics. Junior and senior high school curriculum has not been accommodated STEM approach because the core competence and basic competence based on each subjects.

LITERATURER VIEW

STEM education is a term used to refer collectively to the teaching of the diciplines within its umbrella – science, technology, engineering, and mathematics – and also to a cross –disciplinary approach to teaching that increases student interest in STEM relative fields and improves students' problem solving and critical analysis skills. STEM as an entity itself. Integrated STEM education is not just the to put of technology and engineering layers onto

standar science and mathematics curricula. Instead, integrated SEM education is an approach to teaching that is larger than its academic parts [4].

The concept of STEM is not new, the practice of integrating content subjects such as math and science is not a new idea. The idea of content integration was originally explored more than a century ago by the Committee of Ten at Harvard as a way to standardize the agrarian school system of the late 1800's., the spirit of integrated instruction in STEM was actually honored in education more in the late 19th century than it is today, as the nation's economic focus moved toward industrialization. In the early 1990's, the National Science Foundation of the USA formally coined the STEM acronym we use today to refer to the *individual* content disciplines of Science, Technology, Engineering, and Mathematics, but without the intent to formally integrate the subjects in schools [5].

The teaching and learning in science, technology, engineering and mathematics field have developed become a meta-discipline, an effort to integrate the teaching and learning process in those fields is focused to find innovative solutions for complex problems in this world nowadays. To improve the teacher and learning process in those fields, we have to integrate the application of technology and engineering into science and mathematics teaching and learning process. STEM approach trains the students to solve problems comprehensively from both sides. If we want the teaching and learning process by using STEM approach in schools is success, then we have to improve the competence of the teacher to integrate the application of technology and engineering into science and mathematics teaching and learning process. Therefore, teachers can supervise and teach the students so they acquire very broad knowledge in those four fields [6].

Research carried out by [7] H. El-Deghaidy showed that teachers did not have sufficient understanding of the T in STEM. It also showed that science teachers may not have an adequate understanding of the nature of science and technology and the interactions between these two disciplines, The findings of the study showed that all the teachers expressed concerns that they are underprepared to use STEM applications with their students in the classroom. Lack of teachers' preparation to implement STEM practices may explain their views of interdisciplinary teaching and learning across STEM subjects. It also showed that science teachers may not have an adequate understanding of the nature of science and technology and the interactions between these two disciplines, when and if integrated.

METHODOLOGY

The research utilized design research model that can be classified as interventionist model. The aims was to design and develop an intervention as a solution to a complex educational problem and to enhance understanding about the characteristics of these interventions and the processes to design and develop them [8].The preparation started with a clear understanding about STEM. Then, researcher determine the teaching and learning starting points.

William [9] suggested that the interactions between subjects are most usefully teacher initiated, the disposition of teachers to work together can be facilitated through 'top down' initiatives. The interaction between STEM subjects by fostering cross-curricular links in a context where the integrity of each subject remains respected The current state of research would seem to indicate that a STEM approach to an integrated curriculum is a flawed concept, and would have consequences for Technology Education that are undesirable.

The research take Sutarto Hadi's [10] suggestion in the prosessog preparation. He suggested steps that could be carried out in order to improve the success of teaching improvemsnt. Sutarto Hadi had been developed model of teacher's professional development. Sutarto Hadi used this model to improve the professional of junior high school teacher. He suggested three min steps: workshops, teaching and reflection. Since the research focused on lesson plan preparation process, the research carried out several meeting as a shorter form of workshop. Through the workshops the teachers deepen their understanding about teaching content, STEM approach, and learning prpcesses.One of the finding from Sutarto Hadi (2002) research that model of teacher's professional development is a good model for developing professionality of mathematics teacher in Indonesia, particularly in introducing a new approach in teaching mathematics.

The research involved one mathematics and one science teachers in one private school in Yogyakarta. The school participatd iin the research was selected on the convenient based. The school is one of the researchers' institution partners in term of teacher education, particularly as the school where the student teachers doing teaching practice. Meanwhile, the teachers involved in the research were requested by the researchers. The researchers was asking permission for the school principal for the involvement of the teachers upon the availability of the teachers.

RESULT

The research provides information regarding lesson plan preparation for teaching with STEM approach. Since the approach is relatively new in Indonesian context and also new for theteahers participated in the research, the process of lesson plan development need to be recorded and discussed.

Table 1. Stages of lesson plan preparation, the agents activities, outpot of the activities, and the opportunities and the challenges in regard to the Indonesian contexts.

Stages of lesson plan preparation	**Researchers Activities**	**Teachers activities**	**Researchers dan teachers activities**	**Output**	**Opportunities and challenges**
1	Classroom observation				
2	Presenting the idea of STEM approach to the teachers			Teachers understanding about STEM approach	
3		Identify teaching topics in one semester		List of teaching topics in one semester	Opprotunity: Ministry of Education provides content standard consisting topics to be taught. rearrange topics
4			Identify possible topics potential to be integrated	List of possible topics to be integrated. Statistics and Electricity	Teachers are allowed to rearrange topics within semester Challenge: Rearrange mathematics and Science time
5			Identify 'real world' fenomena to be discussed	Real phenomena to be studied	Challenge: Finding out real phenomena and ensure that all teaching content within the topics could be 'covered' in the activity.
6			Develop teaching preparation	Lesson plan Teaching materials Teaching media Students worksheet	

Information about agents, activities, outcomes and opportunities also the challenges presented in Table 1 shows significant information regarding the process of lesson plan preparation. As a process to prepare teaching with a new approach in Indonesian schooling system, the information presented in the Table worth to discussed. The data shows several pictures:

1. As a new approach, STEM approach was presented to the teachers. In Indonesia education system, teachers do not normally initiate new approach of teaching unless it recommended by government officials or mandated in government or official document. This situation may also occur in other country. In term of teacher professional development, this situation need to be take into account, that is to encourage teachers initiate new approach for their teaching.
2. Indonesian teachers have more advantages in term of identification of topics to be taught. The Ministry of Education and Culture provides content standard in which the topics to be taught in each level of education and grades is presented. The teachers have the opportunity to rearrange the prescribed topics within semester.
3. One of the biggest challenge in the lesson plan preparation was rearranging the topics that has a potential to be taught by using real world phenomena through which science and mathematics topics can be discussed. The rearrangement also involve school administration since it need to rearrange lesson timetable.
4. Another big challenge was to find out real phenomena from daily life which is also familiar to students. Selecting and finding out real phenomena is a crucial part of the preparation. The researchers and teachers have to ensure that all topics could be discussed through presented phenomena, The inclusion of all topics is paramount in the Indonesian schooling system since the centralized exam system is part of the system.
5. As the phenomena selected, the process of teaching activities design is need to be plan carefully in order to consistently implement the idea behind STEM approach that is to improve studets' learning capability. The teaching and learning process has to be designed from the point of view students learning. The activities should be selected which most suitable for students to carry out learning.

CONCLUSION

The data collected from the research consisted of list of teaching topics, lesson preparation, teaching video, and students' works. This paper focuses on the result of data analysis regarding lesson preparation process, and the challenge during the preparation of the implementation of STEM Approach in Indonesian schooling system.

The research shows provide information regarding the process of lesson plan preparation toimplement a new teaching approach with its dynamics.

RECOMMENDATION

In order to improve teachers capacity and self-confident to implement new approach, lesson plan development may be repeated with gradual increase of the roles of the teachers and gradual decrease of the roles of the researchers.

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